Claims

1. A method of analysis of an object, the method including the steps of:

generating non-planar penetrating radiation;

diffracting the radiation from a monochromator to provide a beam of monochromatic penetrating radiation;

irradiating a portion of the object with the beam;

diffracting radiation that passes through the object onto a detector from an analyser;

rotating the analyser through a plurality of angular positions; and

measuring the intensity of the radiation incident on the detector as a function of analyser position.

2. The method of claim 1, including the step of determining a complex scattering function of the portion of the object under analysis from the intensity measurements.

3. The method of claim 1 or 2, including the step of passing the beam of radiation through a slit prior to the beam's incidence on the object, the slit size A in a direction transverse to the direction of propagation of the beam being calculated such that:

$$A \leq \lambda/\delta\theta$$

where λ is the wavelength of the incident radiation, and

$\delta\theta$ is the optical resolution of the apparatus used in implementing the method.

4. The method of any preceding claim, wherein the analyser is rotated in incremental steps α:

$$\alpha \leq \delta\theta/2$$

where $\delta\theta$ is the optical resolution of the apparatus used in implementing the method.

5. The method of any preceding claim, including the use of a PIN diode detector to detect the radiation reflected from the analyser.

6. The method of any preceding claim, wherein the radiation is produced using a characteristic line source.

7. The method of claim 6, wherein the characteristic line source is a rotating anode source.

8. The method of any preceding claim, including the step of calculating a complex scattering amplitude of the irradiated portion of the object from the detected intensities, and including the step of determining a complex scattering function of the irradiated portion by taking an inverse Fourier Transform of the complex scattering amplitude.

9. The method of claim 8, including the steps of:

normalising the detected intensities;

calculating the modulus of the complex scattering amplitude from the normalised intensity;

calculating phase information for the complex scattering amplitude from the modulus of the complex scattering amplitude; and

determining the complex scattering amplitude from the modulus and phase information.

10. The method of claim 2, 8 or 9, including the step of determining a complex refractive index profile of the irradiated portion of the object from the complex scattering function.

11. Apparatus for the analysis of an object, the apparatus including:

a source of non-planar penetrating radiation;

a monochromator for diffracting the non-planar penetrating radiation to provide a beam of monochromatic penetrating radiation;

a detector for detecting radiation that passes through the object;

an analyser for diffracting radiation that passes through the object onto the detector;

means for rotating the analyser between a plurality of angular positions; and

means for recording the intensity of the radiation incident on the detector as a function of analyser position.

12. The apparatus of claim 11, including means for determining a complex scattering function of the portion of the object under analysis from the intensity measurements.

13. The apparatus of claim 11 or 12, including a slit member defining a slit through which the radiation beam passes prior to the beam's incidence on the object, the slit size A in a direction transverse to the direction of propagation of the beam being such that:

$$A \leq \lambda/\delta\theta$$

where λ is the wavelength of the incident radiation, and

$\delta\theta$ is the optical resolution of the apparatus.

14. The apparatus of claim 11, 12 or 13, wherein the analyser is rotated in incremental steps α:

$$\alpha \leq \delta\theta/2$$

where $\delta\theta$ is the optical resolution of the apparatus.

15. The apparatus of any of claims 11 to 14, wherein the detector comprises a PIN diode detector.

16. The apparatus of any of claims 11 to 15, wherein the radiation source is a characteristic line source.

17. The apparatus of claim 16, wherein the radiation source is a rotating anode source.

18. The apparatus of claim 12, wherein the means for determining the complex scattering function includes means for calculating a complex scattering amplitude of the irradiated portion of the object from the detected intensities,

and means for determining a complex scattering function of the irradiated portion by taking an inverse Fourier Transform of the complex scattering amplitude.

19. The apparatus of claim 18, including:

means for normalising the detected intensities;

means for calculating the modulus of the complex scattering amplitude from the normalised intensity;

means for calculating phase information for the complex scattering amplitude from the modulus of the complex scattering amplitude; and

means for determining the complex scattering amplitude from the modulus and phase information.

20. A method of analysis of an object, the method including the steps of:

generating penetrating radiation;

diffracting the radiation from a monochromator to provide a beam of monochromatic penetrating radiation;

passing the beam of radiation through a slit, the slit size A (in a direction transverse to the direction of propagation of the beam) being calculated such that:

$$A \leq \lambda/\delta\theta$$

where λ is the wavelength of the incident radiation, and

$\delta\theta$ is the optical resolution of the apparatus used in implementing the method;

irradiating a portion of the object with the beam;

diffracting radiation that passes through the object onto a detector from an analyser;

rotating the analyser through a plurality of angular positions; and

measuring the intensity of the radiation incident on the detector as a function of analyser position.

21. The method of claim 20, including the step of determining a complex scattering function of the portion of the object under analysis from the intensity measurements.

22. The method of claim 20 or 21, wherein the penetrating radiation is non-planar penetrating radiation.

23. The method of any of claims 20 to 22, wherein the analyser is rotated in incremental steps α:

$$\alpha \leq \delta\theta/2$$

where $\delta\theta$ is the optical resolution of the apparatus used in implementing the method.

24. The method of any of claims 20 to 23, including the use of a PIN diode detector to detect the radiation reflected from the analyser.

25. The method of any of claims 20 to 24, wherein the radiation is produced using a characteristic line source.

26. The method of claim 25, wherein the characteristic line source is a rotating anode source.

27. The method of any one of claims 20 to 26, including the step of calculating a complex scattering amplitude of the irradiated portion of the object from the detected intensities, and including the step of determining a complex scattering function of the irradiated portion by taking an inverse Fourier Transform of the complex scattering amplitude.

28. The method of claim 27, including the steps of:

normalising the detected intensities;

calculating the modulus of the complex scattering amplitude from the normalised intensity;

calculating phase information of the complex scattering amplitude from the modulus of the complex scattering amplitude; and

determining the complex scattering amplitude from the modulus and phase information.

29. The method of claim 21, 27 or 28, including the step of determining a complex refractive index profile of the irradiated portion of the object from the complex scattering function.

30. Apparatus for the analysis of an object, the apparatus including:

a source of penetrating radiation;

a monochromator for diffracting the penetrating radiation to provide a beam of monochromatic penetrating radiation;

a slit member defining a slit through which the beam passes prior to the beam's incidence on the object, the slit size A in a direction transverse to the direction of propagation of the beam being such that:

$$A \leq \lambda/\delta\theta$$

where λ is the wavelength of the incident radiation, and

$\delta\theta$ is the optical resolution of the apparatus;

a detector for detecting radiation that passes through the object;

an analyser for diffracting radiation that passes through the object onto the detector;

means for rotating the analyser between a plurality of angular positions; and

means for recording the intensity of the radiation incident on the detector as a function of analyser position.

31. The apparatus of claim 30, including means for determining a complex scattering function of the portion of the object under analysis from the intensity measurements.

32. The apparatus of claim 30 or 31, including a slit member defining a slit through which the radiation beam passes prior to the beam's incidence on the object, the slit size A in a direction transverse to the direction of propagation of the beam being such that:

$$A \leq \lambda/\delta\theta$$

where λ is the wavelength of the incident radiation, and

$\delta\theta$ is the optical resolution of the apparatus.

33. The apparatus of claim 30, 31 or 32, wherein the analyser is rotated in incremental steps α:

$$\alpha \leq \delta\theta/2$$

where $\delta\theta$ is the optical resolution of the apparatus.

34. The apparatus of any of claims 30 to 33, wherein the detector comprises a PIN diode detector.

35. The apparatus of any of claims 30 to 34, wherein the radiation source is a characteristic line source.

36. The apparatus of claim 35, wherein the radiation source is a rotating anode source.

37. The apparatus of claim 31, wherein the means for determining the complex scattering function includes means for calculating a complex scattering amplitude of the irradiated portion of the object from the detected intensities, and means for determining a complex scattering function of the irradiated portion by taking an inverse Fourier Transform of the complex scattering amplitude.

38. The apparatus of claim 37, including:

means for normalising the detected intensities;

means for calculating the modulus of the complex scattering amplitude from the normalised intensity;

means for calculating phase information for the complex scattering amplitude from the modulus of the complex scattering amplitude; and

means for determining the complex scattering amplitude from the modulus and phase information.

39. A method of analysis of an object, the method including the steps of:

irradiating a portion of the object with a beam of monochromatic x-rays;

detecting the intensity profile of an angular spectrum of the x-rays emerging from the irradiated portion; and

determining a complex scattering function for the irradiated portion of the object under analysis.

40. A method of analysis of an object, the method including the steps of:

irradiating a portion of the object with a beam of monochromatic x-ray radiation;

diffracting x-rays emerging from the sample into an x-ray detector using an analyser means; and

obtaining an angular spectrum of non-Bragg diffracted x-ray intensities as a function of angular position of the analyser means.

41. A method of analysis of an object, the method including the step of collecting generic x-ray diffraction data from a portion of the object and analysing the data to obtain a complex refractive index of the sampled portion in a direction transverse to the beam propagation.